The Northwestern MILLER

MILLING PRODUCTION SECTION

Separation of Grain by Projection Into Still Air

By E. P. Farrell, Max Milner and Robert Katz

Kansas State College

A machine has been developed to separate grain by projecting it as a continuous stream at uniform velocity into still air. The grain is separated according to the mass of each kernel and according to its size, shape, and surface texture. Kernels of the same mass but different size, shape, and surface texture are projected different distances, as are kernels of the same size, shape, and surface texture with different masses.

Since these are the very factors that determine test weight, this apparatus, called a grain spectrometer, separates various grains on the basis of test weight. The size of the internally infested grain is unaffected by the infestation, but its mass and potential flour yield are affected greatly, particularly for those kernels from which adult insects have emerged leaving only a cast skin to contribute to the fragment-count of flour.

The present report consists of a review of previously published results (1, 2) including a description of the equipment, a study of the variation in some operating characteristics, tests of the fractionation of corn, sorghum and screenings, and operation of the spectrometer as a dry stoner.

EDITOR'S NOTE: The accompanying article is Contribution No. 250, Department of Flour and Feed Milling Industries, and No. 50, Department of Physics, Kansas Agricultural Experiment Station, Manhattan. E. P. Farrell and Max Milner are staff members of the Flour and Feed Milling Industries Department at Kansas State College, and Robert Katz is a member of the Department of Physics staff. This paper covers material presented at the 1954 Technical Conference of the Association of Operative Millers by Prof. Farrell. The research reported here was supported by a grant from the Millers National Federation.

Apparatus

The grain spectrometer, illustrated diagrammatically in Fig. 1, consists of feed hopper A, and two parallel belts B and C 5 in. wide, driven at the same speed. The upper belt C, confines the grain on the lower belt B which runs on a smooth wooden deck. The space between the belt is variable, and is approximately that of a single layer of grain. The function of belt C is to cause the grain to assume the velocity of the moving belt B without bouncing or sliding, and thus to be projected into space as a regular stream. Side boards (not shown) keep the stock from spilling off the sides of the belt.

The projected grain falls into a receiver divided into a series of 48 individual hoppers or bins 6 in. in length, the first located directly below the point of projection. With the 5-in. belt width used in the present machine, hoppers 24 in. wide were found to be satisfactory.

Table 1—Separation of Infested From Sound Wheat

Bin No.	Fraction of original sample by weight %	Fraction infested by kernel %
Original sample	100.0	8.5
21	0.1	27.0
22	0.1	40.8
23	0.2	45.3
24	0.3	29.5
25	0.6	33.4
26	0.4	30.9
27	2.2	30.9
28	4.8	12.5
29	8.2	11.7
30	14.0	7.9
31	20.2	6.0
32	23.9	1.5
33	17.7	1.9
34	6.3	0.2
35	0.8	1.1
36	0.2	2.7

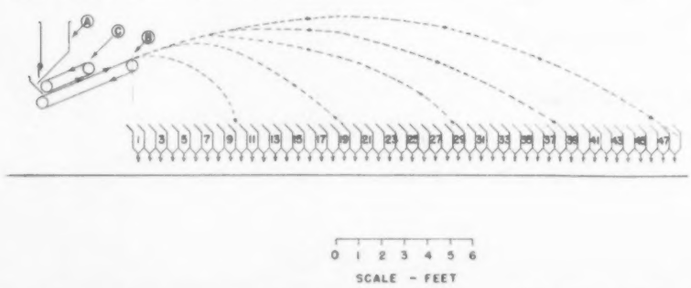

FIG. 1—Grain Spectrometer. Grain from hopper A enters between moving belts B and C and is projected into still air. The separated grain is collected into a series of 48 bins, shown approximately to scale.

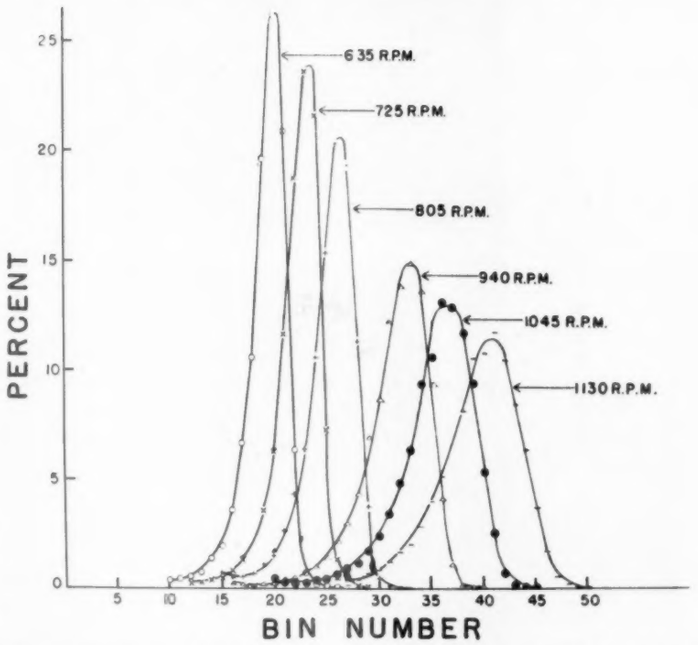

FIG. 2—Distribution of wheat fractions at various speeds, using a constant projection angle of 30 degrees. To convert r.p.m. to lineal speed of the belt in feet per minute, multiply by 1.57.

Experimental Results

Influence of operating variables. In order to determine operating condi-

(Continued on page 17a)

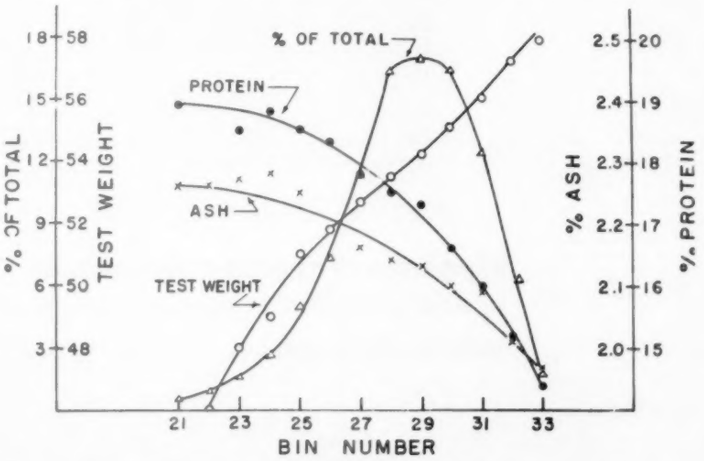

FIG. 3—Curves showing test weight, protein and ash characteristics of separations from a sample of wheat testing 53.5 lb. per bushel, 17.0% protein and 2.08% ash.

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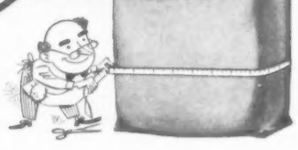

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Flow of Bulk Solids

By Andrew W. Jenike

Bulk materials do not always flow readily out of bins and through processing equipment. Little basic work has been done to determine conditions governing flow of bulk solids, and no comprehensive method of design is available to the engineer to assure that his design will perform satisfactorily. In an attempt to correct this situation, the writer has been working during the past few years on a method that aims at putting design for flow of bulk solids on a quantitative basis.

The work has been reported in Bulletin No. 64 of the Utah Engineering Experiment Station (University of Utah, Salt Lake City, March, 1954), and in a paper presented at a recent meeting of the A.S.M.E. (paper No. 54-SA-34). In brief, the theory of flow can be stated as follows: A loose bulk solid has no strength, it slips through one's finger. In a bin, under pressure, a solid compacts and builds up strength. When the gate is opened or the feeder started, conditions of support of the mass are changed with resulting redistribution of pressures. If the new pressures are higher than the strength of the solid, the solid flows, otherwise, an obstruction develops.

The work has been based on observations of industrial installations and on tests made with model bins. A novel pressure gauge has been developed and used to measure pressure within material. These tests have produced significant results. Fig. 1 shows a hopper filled with sand with gauges placed to measure vertical pressure along the centerline of the hopper. At the right, a diagram shows the value of unit pressure or head, v/w. V is the measured pressure and w is the unit weight of the sand. We see from the diagram that unit pressure increases linearly from the top of the filling down to a certain height, reaches a maximum and then falls off toward zero at the apex of the hopper. This behavior is typical of bulk solids and is confirmed by industrial experience. As a matter of fact, were pressure in a solid to increase linearly all the way down the bin, as it would in a liquid, feeders would be severely overloaded and would require a great deal more power to operate.

Fig. 2 shows a bin with similarly placed gauges. From the pressure curve we see that in the vertical portion of the bin pressure increases with depth down to the transition to the hopper. At the transition, pressure drops abruptly and then picks up again within the hopper. As a result, unit pressure within the hopper is practically independent of the level of the solid in the bin. This explains why, in so many cases, flow of a solid through a hopper is unaffected by the level of the solid in the bin.

EDITOR'S NOTE: The accompanying article is "Progress Report No. 1" on the "Flow of Bulk Solids" by Dr. Andrew W. Jenike of Salt Lake City, Utah, materials handling consultant. The work reported here was initiated and financed by the author.

Formulas of Flow

Another significant step toward the development of a quantitative method of design has been made with the derivation of formulas of flow of bulk solids and with the determination of a property of solids which governs their flowability. The property, called the flow-factor, is obtained on apparatus developed for this purpose and shown in Fig. 3. This is a transverse shear testing machine on which we measure effective cohesion and angle of internal friction from which we compute the flow-factor. This machine can also be set up to measure unit weight of a solid as well as adhesion and angle of friction between a solid and a sample of a bin wall.

Although we have a lot of work to do yet, before quantitative design data can be made available to designers, several conclusions of practical value have already been drawn, and here are some of them.

It is important to keep compacting pressure within material low. The higher the pressure, the more strength a solid builds up, and the more it tends to obstruct flow.

A sufficiently large opening in the hopper is necessary to assure flow. The size of the opening depends on the other dimensions of the bin and on the flow-factor of the handled solid. Formulas of flow relate these quantities. When the formulas are fully developed, they will enable us to design with a good degree of certainty of performance.

When material is fed into a bin, it falls a certain height, gains momentum, and hits the filling with a force which produces local compaction and tends to wedge the mass of material within the hopper. Wedging produces high lateral pressure which compacts material and leads to obstructions. To a degree, the steeper the hopper, the more severe is wedging.

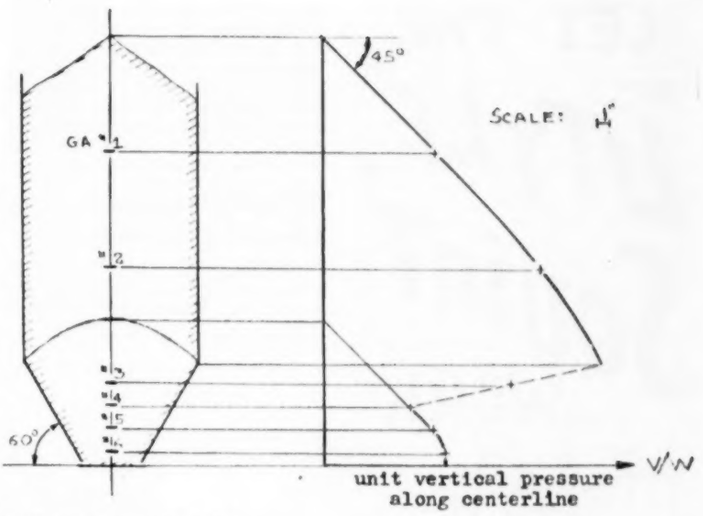

FIG. 2—Pressure in a bin.

Fine Materials

Fine and flaky materials, which are adequately braked by air friction, are free from wedging and flow best in very steep hoppers. The hoppers can reduce to small openings with cheap gates or feeders. For other materials, hopper slopes should not exceed 60° and, if wedging occurs, horizontal ledges can be mounted within the hopper to increase friction at the walls. When self-clearance is necessary, the ledges can be inclined at an angle of 45° to the horizontal and vibrators can be used for final clean out.

When self-clearance is not required, flat-bottom bins provide a good solution. Dead material compacts around the opening to form a natural hopper or crater which controls wedging and produces smooth flow, Fig. 4. The process of compaction of the dead material may take days or even weeks. During this initial period of operation, flow is erratic but, once a firm crater has formed, flow improves. Pre-compaction by mechanical means can eliminate this difficulty.

The dead material of the crater should not be disturbed by barring, air jets or vibration. When air jets are required to break up funneling, they should be located above the crater. Suspension bunkers are flexible, tend to disturb the dead material of the crater and therefore are less conducive to flow than rigid bins.

Sometimes material domes at the transition from the vertical portion of a bin to the hopper. This is a sign that pressure at the transition is too high. To reduce pressure in this area, it is necessary to provide additional support to the mass of material above the transition. This is done by either providing horizontal ledges within the bin or by reducing the effective diameter of the bin by means of vertical partitions.

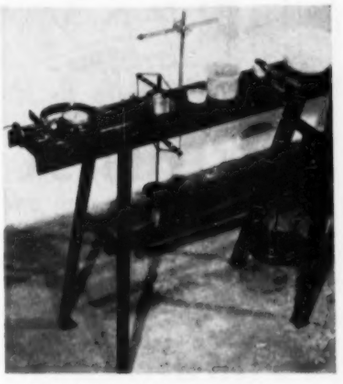

FIG. 3—Shear testing machine.

In all cases the knowledge of the

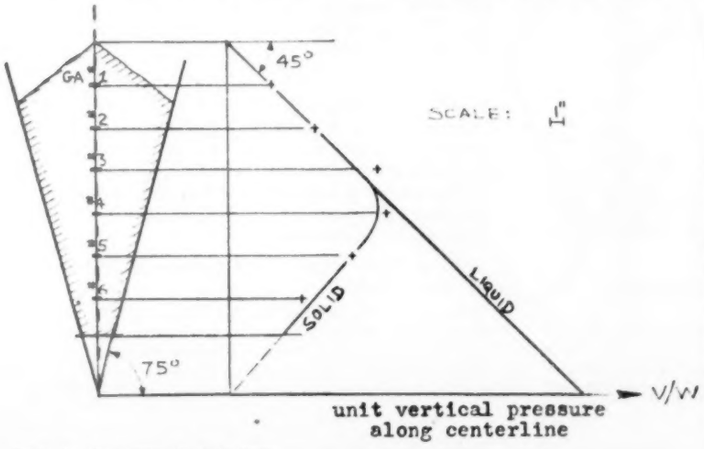

FIG. 1—Pressure in a hopper.

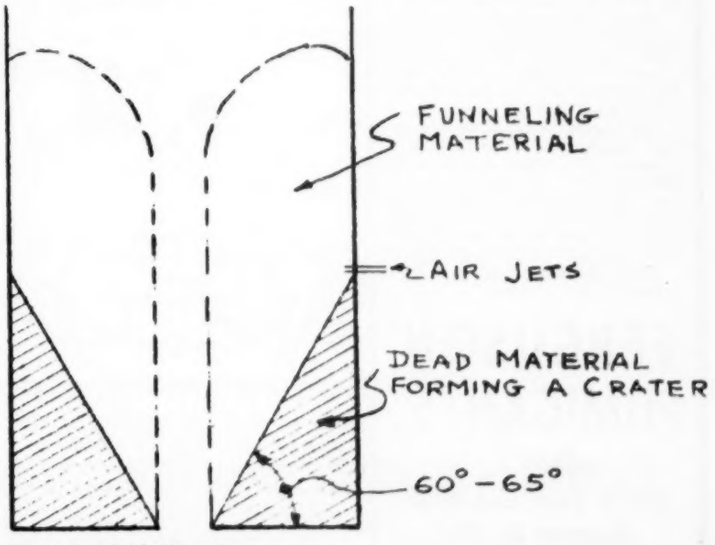

FIG. 4—Flat-bottom bin

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flow-factor of the solid is very useful in diagnosing the cause of an obstruction and in prescribing a remedy. When moisture content of the solid varies, it is necessary to measure the flow-factor for the whole range in order to determine the critical condition.

—BREAD IS THE STAFF OF LIFE—

Williamson Company Produces Pellet Mills

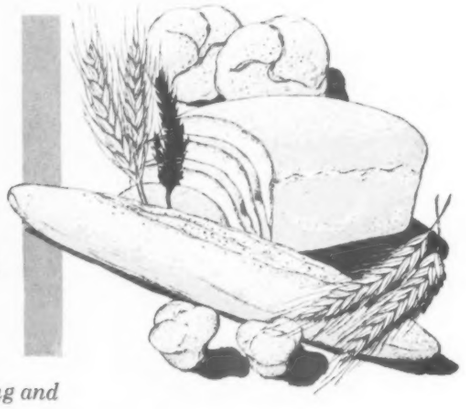
MONTEBELLO, CAL. — John W. Williamson & Sons, Inc., has announced the acquisition of exclusive manufacturing rights to the Cyclops and Universal pellet mills. Glenn Y. Williamson, general manager, said the company will be sole licensee for all manufacturing, sales and service of the mills.

"New models of both the Cyclops and Universal mills incorporating patented improvements are now in production at the Montebello plant of the Williamson company," Mr. Williamson said. "A complete inventory of replacement parts will be carried by Williamson, which will furnish all maintenance for mills now in use.

"The new Cyclops mill, a heavy duty model, will be capable of producing 5 to 20 tons an hour of 3/32-¾ in. round, cubed or oblong pellets—depending on materials being handled. The regular duty Universal mill will also feature increased production and an improved maintenance schedule."

Present facilities of the Williamson firm, which manufactures complete feed mills, livestock feeding plants and accessory equipment, will be utilized in the construction of the new pellet mills.

FLOUR FOR MAN'S BREAD*



A Brief History of Milling and Baking by SCIENCE WRITER

CHAPTER IV. *The Business of Milling Begins.*

MILLING LEAVES THE HOME

Beginning about 1000 B.C. in Eastern Mediterranean countries an improvement in grinding methods caused an increase in output so that a man's labor produced more grain than his family needed. He had a small surplus to sell or exchange. Thus, milling began to move out of the home and became a commercial activity.

THE GREEKS FOUND A WAY

Then about 500 B.C. the Greeks, who were not burdened by the orthodox attitude of the Egyptians and Mesopotamians, experimented with new grinding methods and tools. Within less than 100 years these alert people found much more efficient ways to mill.

In fact, the new devices were so productive that they were essentially industrial machines, housed in factories. These Grecian enterprises were really a combination of miller and baker. Grain was milled to flour, then bread was baked from that flour. Men (mostly slaves) and animals powered the mills.

ROMAN BREADS AND MILLER-BAKERS

The Romans, who were slow to adopt new ideas, finally took to themselves the practice of public milling from the Greeks and then developed it to such a degree that one bakery in Rome produced between 100,000 and 150,000 loaves daily. Even by today's standards that was mass production.

The Roman breads were forerunners of ours. Their loaves were round, about 2 inches high, and were made from kneaded doughs in which leavens and carefully sifted flour of the bread wheats were used. However, it would be difficult to market them today in competition with our feather-light, enriched white bread; they were so heavy that the loaves sank in water.

THE HEALTH OF MILLIONS

Since the days of Greece and Rome when the foundations were laid for today's great baking and milling industries, the world has gained much knowledge. It is remarkable that in all that time the science of nutrition has flourished only within the last fifty years or so. An accomplishment of this science, and the millers and bakers who adopted it, is the enrichment of white flour and white bread with vitamins B_1 and B_2, niacin and iron. Thus is the health of countless millions throughout the world benefited.

This is one of a series of articles which is being published in professional nutrition and dietetic journals, and which will be widely distributed for educational purposes. Reprints of this and all other chapters are available without charge. Write to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

The next chapter titled: "The Evolution of Millstones" will be published soon.

*This is the title of a definitive history of milling by John Storck and Walter Dorwin Teague, published by the University of Minnesota Press at Minneapolis and copyrighted by the University of Minnesota. It is used with permission as a source of material for this series of advertisements.

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Developments and Problems In Wheat Quality Research

So long as wheat was ground on a stone mill and baked in the home, the matter of quality was of relatively little importance. However, with the advent of steel rolls, modern sifters, and other refinements in mills and the development of large mechanized bakeries, differences in milling and baking quality of flour became important.

Around the turn of the century several state agricultural experiment stations set up experimental laboratories to study the problem. It was soon shown that both variety and environment under which the grain was produced had an important influence on quality. These early laboratories had an important influence in preventing the release of poor-quality varieties from the breeding programs and in promoting the development of varieties with better quality than those previously grown. It may be recalled that the good quality of Marquis, first indicated by the chewing test, was confirmed in the milling and baking laboratory at Ottawa.

EDITOR'S NOTE: The accompanying article is reprinted from "AACC Transactions," published by the American Association of Cereal Chemists. The article is from a presentation made at the Conference on Wheat Research sponsored by the National Association of Wheat Growers in Peoria, Ill., last fall. The author was the late B. B. Bayles, who was with the field crops research branch, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.

The Cereal Section started work on wheat quality in 1915 in cooperation with what is now the Grain Division, Agricultural Marketing Service, located at the Beltsville Research Center. This laboratory from the beginning has been concerned with the development of fundamental information on the physical, chemical, and other properties of wheat varieties which determine their milling and baking behavior and with the development of technics for measuring quality for different uses. This basic research has been essential in order to properly evaluate varieties and material from the breeding programs so as to avoid distribution of varieties of unsatisfactory milling and baking quality. Prior to 1936, work on all classes of wheat was conducted in this laboratory. At present it is concerned primarily with the hard red spring and durum wheats.

In the early 1930's the need for additional research on wheat quality and for testing the wheats developed in the breeding programs became urgent. Each state experiment station in the wheat-growing areas could not afford to develop a laboratory, but as a result of group action from the states concerned, a cooperative laboratory was established for soft winter wheat at Wooster, Ohio, in 1936; for hard red winter wheat at Manhattan, Kansas, in 1936; and for western wheat at Pullman, Washington, in 1946. The states of Kansas, Minnesota, Nebraska, and North Dakota already had laboratories.

Two Classes of Work

Each of the cooperative laboratories is concerned with two general classes of work. First, the evaluation of materials from the breeding programs of all state experiment stations in the region. They are the only facilities available for testing breeding materials from most of the experiment stations. Many thousands of samples have been tested during the last 35 years. With the exception of Rex, which was distributed before these laboratories were established, no variety of unsatisfactory quality has been approved for release from the breeding programs cooperative with the state experiment stations.

It is also of great significance that many of our present varieties, because of rigid selection in the laboratories, are better with respect to certain quality characteristics than the varieties they replaced. Varieties with the quality of Thatcher, Tenmarq, Comanche, Nebred, and Vigo are not "just accidents." Such varieties as Chiefkan, Red Chief, and Early Blackhull are examples of varieties developed for agronomic type without benefit of cooperation with a quality laboratory.

The second type of work in the laboratories has been research to learn the physical, chemical, and other characteristics of wheat that determine quality for each of the many bakery and other products made from it, and the development of technics for measuring these characteristics.

It is generally recognized that quality characteristics required by the miller, baker and other processors are somewhat different for each mill and bakeshop, and that they have changed over the years with the introduction of improvements in ingredients other than flour, high speed mixers, highly mechanized shops, the shift from batch mixing to continuous and automatic pro-

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cessing in the shops, shorter working hours, and many other factors. Because of these differences and changes in requirements, our objective has been to determine the specific physical, chemical, milling, baking and other characteristics of the varieties tested. Such information makes it possible to interpret their value for any use. This approach necessitated not only the development of adequate milling and baking procedures, but also the development of basic research into the structure of the wheat kernel and the physical properties and chemical composition of the different tissues in it which determine quality for each of the many bakery and other products made from wheat.

Outstanding Achievements

A few outstanding achievements and something of their meaning in relation to our current problems may be mentioned here.

One of the really significant achievements, it seems to me, is our better understanding of the complex relations between protein and bread quality. Early experimental work suggested that the relation between protein content and loaf volume of bread was curvilinear; or, to put it another way, 1% of protein at the 11% level had more influence on loaf characteristics than 1% at the 16% level.

In spite of this, when protein content of a crop averaged low, millers would pay good premiums for high protein shipments to blend with low protein wheat. Many of the early studies on the relation of protein content to loaf volume of bread were made using lean formulas, mixing time and other technics that did not provide conditions for the expression of potential strength of a flour.

In studies at Manhattan in the 1930's it was found that when rich formulas, sufficient oxidation, and proper procedure were used, the expression of protein strength was not limited and the relation between protein and loaf volume was linear between the limits of protein encountered, 8% and 18%.

Employing procedures and formulas that allowed for full expression of strength, it was then shown that the quality of bread from the best hard winter wheats was as good as that from the best hard spring wheats, at a given protein content. On the other hand, the quality of bread from some varieties such as Chiefkan, a winter wheat, and Progress, a spring wheat, was significantly low at all protein levels. The increase in loaf volume for each percent increase in protein varied from 40 cc. for Progress and 47 cc. for Chiefkan to 73 cc. for Nebred and 78 cc. for Regent.

Recognition of the fact that the relation between protein content and bread loaf volume is linear within a variety greatly simplifies the determination of the bread-baking quality of new strains. Even two or three samples of a new strain at different protein levels establish with remarkable accuracy its protein-loaf volume regression in relation to standard varieties.

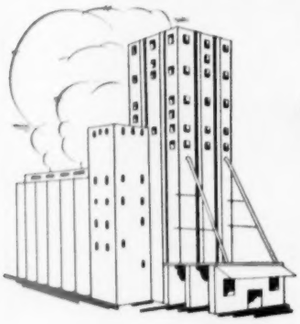
Some characteristics such as protein quality are influenced relatively little by the environment under which the crop is grown, except when temperatures between heading and maturity are very high. Chiefkan, for example, practically always makes a poor loaf of bread in relation to its protein content. Quantity of protein, on the other hand, may vary in the same variety from 7 to 20% when grown under different environments. The quantity of protein in the grain is determined by the available nitrogen in the soil during kernel formation in relation to other factors that determine yield. In general, higher yield per acre has been associated with lower protein content for different varieties grown under the same environment and for the same variety grown under different environments. Recently, however, we have developed varieties which average 2 to 3% higher in protein content than the varieties they are replacing in the Southeast. They are also higher in yield per acre.

Biological Material

In all our work on the properties of wheat, we must recognize that we are dealing with a biological material that may vary either as a result of inherited characteristics or as a result of a change in the expression of these characteristics under different environments. Differences in chemical composition or kernel structure between varieties grown under one environment must be verified on samples grown under different environments to evaluate the influence of environment on expression of inherent characteristics.

Flour fractionation studies in the late 1930's by the Manhattan laboratory showed the gluten fraction to be primarily responsible for differences in the quality of bread from different varieties, with minor differences due to a water-soluble fraction. Recent work at that laboratory opens a completely new approach for studying the basic properties of wheat proteins. I refer to leaf feeding with urea, by which protein content of the grain can be greatly increased without affecting its quality and leaf feeding with other compounds which do affect the quality of protein laid down in the grain. This approach may enable us to alter the content of elements like sulfur in proteins and learn their effects on quality.

Further study of the basic properties and composition of the starch tailings fraction which the Wooster laboratory has found so important



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Need for deep fumigant penetration and diffusion is not confined to flat storage treating. Very often in this surplus storage era there is lack of immediate turning room. Or needed transferring has been done—followed by filling up. Or transferring time for fumigation is so lacking that ability to "top-treat" represents a big saving in time and effort.

Still more important is the problem of extra-deep bins—bins varying from 110 to 160 feet in depth. Unless special measures are adopted (See *Weevil-Cide Fumigation Handbook*, page 16.), there will be failures in extensive sections of the lower bin area with **either** layer or surface application. These special measures involve **applying no dosage** until the bin is approximately half full, then treating a 60 to 80-foot column grain with a single application. **Most fumigant types won't do it. Yet such penetration becomes a necessity in deep bin fumigation.**

Of the 10 basic types of grain fumigants, 7 just don't have the penetration and diffusion needed for stationary or flat storage treating of deep masses of grain. Of the three other types, one lacks effectiveness except at high dosage and cost.

Of the two remaining types (which include Weevil-Cide)—both carbon tetrachloride-carbon bisulphide mixtures—**only** Weevil-Cide, **through processing**, is free from partial separation of essential components in filtering through a deep grain mass; **only** Weevil-Cide, **through processing**, is free from the threat of flame propagation (explosiveness) in the presence of a source of ignition. This may be of vital importance where the whole fumigant dosage is applied on a sizable grain surface, liberating large concentrations of gas inside the storage structure.

The Weevil-Cide processing method not only serves to fireproof the product, but also produces in bulk grain a unique combination of penetration, diffusion and sorption. This combination makes Weevil-Cide far more efficient in fumigant action than any grain fumigant containing or consisting of chemical compounds which, though more toxic, lack one or more of these essential characteristics. This same combination makes Weevil-Cide more effective and consistent than other, but unprocessed, mixtures containing the same chemical compounds. That is why Weevil-Cide is the most adaptable of all grain fumigants.

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in determining cookie quality should clarify many problems in connection with milling and utilizing soft wheats. The unusual properties of this fraction could prove to be useful for other industrial products.

Recent studies have shown that varieties can be developed which have not only excellent quality of gluten for making bread but also other characteristics for making good cookies. Wheats of this type may prove of value especially in transition areas between hard and soft wheat regions.

Studies at the Wooster laboratory on the distribution of protein and ash in different parts of the grain helped to explain protein and ash differences in mill streams.

Quick Tests

Many quick tests which measure characteristics that influence quality for specific uses and add to our basic knowledge of the wheat kernel have been developed and are being used in evaluating breeding materials. They include such tests as the pearling and particle size tests to determine kernel hardness, rate of flow and bran clean-up in a micro mill, water retention by gluten in bread wheat varieties and by a starch tailings fraction in soft wheat varieties, alkaline viscosity for cookie quality, the disk test for durum quality, and many other tests each of which measures a specific characteristic.

These characteristics, which in total determine quality for various uses, are all definite varietal characteristics. Each is definitely inherited and the breeder can recover them in improved varieties in their present form or in new combinations as desired, provided, of course, that the laboratories have available the technics and facilities for analyzing small samples of grain and telling the breeder which lines from a cross have the desired combination of characteristics.

The list of characteristics to be brought together in breeding a new wheat variety might be compared to a blueprint of specifications for the construction of a building, except that building a wheat variety to specifications laid down by the farmer, the processor, and the consumer is much more complicated.

First, characteristics such as resistance to disease, ability to stand in the field without shattering or lodging, ease of threshing, and above all, yield, must be included to satisfy the farmer. Then kernel structure must be such that the miller can produce a high yield of quality flour. This means a bran from which the endosperm can be cleanly and easily separated, and endosperm that will grind into flour of proper fineness and pass readily through the sieves. Yield of flour and rate of flow through the mill are both very important to the miller. There is definite evidence that varieties better than present commercial types in both these characteristics can be developed.

Along with the characteristics desired by the farmer and the miller, the breeder can build in the characteristics desired for specific bakery products, for the making of various prepared breakfast cereals, for the processing of gluten or starch, or for any other industrial use.

Before the breeder can put these characteristics together, however, he must have a blueprint specifying those desired, and technics must be avaliable for selecting parent varieties that have each of the desired characteristics. In addition, technics and facilities must be available for testing large numbers of segregates from the crosses to determine which strain contains the desired recombination of characters. I might point out that some 13,000 wheats from all parts of the world are available in our collection. From this collection, many have been picked for use as parents to introduce valuable characters such as short straw, resistance to lodging, resistance to disease, and other characteristics into commercial varieties.

There are, undoubtedly, many characteristics in these world wheats which determine quality and which would be very useful in commercial varieties to improve their quality for milling, baking, or for special industrial uses. One of the needs is a study to determine what new properties may be present in these wheats.

It seems clear that the greatest use for wheat will continue to be for human food, whether for domestic or foreign consumption. It is only within recent years that we have had a clear concept of the quality characteristics desired for major products such as bread, cakes, and cookies. Our knowledge of the quality characteristics desired in flours used for crackers, doughnuts, pie crusts, and many other products is still vague. A more complete knowledge of the physical and chemical characteristics of wheat and flour will make it possible to develop varieties with better milling and baking properties than any of our present varieties and should suggest completely new uses. Likewise, with few exceptions we know little of the specific requirements of countries that import wheat. Only a bare beginning has been made in producing varieties especially suited for any of these needs. It re-

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quires no stretch of the imagination to suggest that a better understanding of what is needed, followed by tailor-made varieties to supply these needs, would do much to increase the demand for wheat from surplus-producing areas such as the Pacific Northwest and the Great Plains.

The breeding of tailor-made varieties can be developed only when we have a knowledge of the materials available, the influance of environment on the expression of quality characteristics, the needs of the industries now using wheat, or new uses that may be developed. We cannot reasonably expect to acquire this knowledge without more basic research relating to the physical and chemical characteristics of wheat and flour.

—BREAD IS THE STAFF OF LIFE—

Feed Production Men's Views on Needs Outlined

Some feed production men's views on developments and needs in feed manufacturing procedures and equipment were outlined recently by Lloyd Larson, executive vice president of the Midwest Feed Manufacturers Assn., Kansas City.

Speaking at the 1954 mid-year meeting of the Grain Processing Machinery Manufacturers Assn. at Three Lakes, Wis., Mr. Larson quoted comments from a survey of feed manufacturers.

A number of the feed men indicated that they believed the entire feed processing system, including plant design and machinery, needs critical study and research if manufacturing is to keep pace with new developments in animal nutrition and feeding practices.

"Automation" Trend

The growing trend toward process control and "automation" in all industry was mentioned as a trend certain to influence feed processing. One of the feed manufacturers urged that these industrial advances be given careful consideration in the design of new feed processing equipment and feed plants.

Another manufacturer, citing what he called variability in certain aspects of feed manufacturing, said that the entire processing system needs study and that there is generally a need for more process engineering preceding the "nut and bolt" part of the feed plant design.

This manufacturer said that when one considers the probable life of a feed plant, every effort should be made in the initial design to anticipate trends years in the future.

Plant Integration

One production man noted that modern feed production is a specification process, and he said the industry needs equipment designed to give the requisite process control to fit this modern operation. "Specification feeds require correlation of the entire feed production system," he said. "Processing units can no longer be considered isolated machines but must be integrated into the system performance-wise and capacity-wise. They should be 'systems - engineered.'"

The accelerated trend toward precision compounding and processing in the feed industry increases the need for sound engineering and performance data, another feed manufacturer said. He indicated that industry standards for judging capacity and performance can be helpful.

Some of the manufacturers who were quoted put stress on research to increase efficiency of feed milling equipment and procedures. One feed man said subsidized research programs through colleges or private research organizations might be the best way for machinery manufacturers to carry out research.

Improved layouts for new installations or plants making major improvements are needed, another feed manufacturer said. He said proper planning initially will eliminate any problem of moving equipment from time to time after the original installation. This same manufacturer went on to say that "anything that could be done to crush grain with the least friction would be desirable."

In commenting on efficiency, one manufacturer said labor costs have risen steadily, and he said there was a need to recover the increased cost of labor through more efficient machinery.

Another feed man said many types of equipment have remained basically the same for years. In considering possible improvements, he said that "there have been many improvements in handling of materials and mixing of liquids through the use of sound waves, and it has occurred to us that possibly something of this nature could be developed for the feed industry."

One feed manufacturer whose firm was building a new mill was quoted as saying that the chief thing different from the old mill was the arrangement of the machinery. Man hours per ton were cut a great deal he said, but much of the equipment is of the same type as before. He added, however, that some of this equipment might be the best that can be devised.

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Preventive Maintenance in Feed Plants

By G. A. Carlson

How many of you feel you have a good preventive maintenance program in your feed plant? I would judge that many of you regard your preventive maintenance program as adequate. Please note that I said preventive maintenance. Now then, what is the difference between maintenance and preventive maintenance as far as your mill machinery and equipment is concerned?

Let us compare your mill machinery with your automobile. This is a machine that all of you are very familiar with. Maintenance on your car means a major repair job which could be caused by lack of lubrication, over-heating due to low cooling water, or let us say just plain negligence. Negligence in the care of an automobile is very costly. Similar treatment of mill machinery may also be very costly and may cause major break downs which will stagger you when you see them in the maintenance column of your ledger. Remember, this repair cost in your ledger does not include the loss of production time due to idle machinery.

Let us get back to your car. Preventive maintenance for your car is essential, and we exercise it on the average of once a week. We have the gasoline station attendant check the oil, check the water, check the battery and tires. He greases the car, changes the oil in the crank case, transmission and rear end. Why do we go to all this bother and expense with our automobiles? We do it to maintain smooth, dependable performance and to minimize expensive mechanical failures in our transportation machines.

I wish to stress transportation machines because your machines in the mill are not unlike present day automobiles. They also require planned preventive maintenance to perform at maximum efficiency with a minimum expense. You must realize that preventive maintenance cannot be built into your production machinery any more than it can be built into your automobile. As a consequence, your mill machinery requires the same careful preventive maintenance to give the best possible performance.

EDITOR'S NOTE: In the accompanying article, G. A. Carlson, chief mechanical engineer of the Strong-Scott Mfg. Co., Minneapolis, stresses the importance of good preventive maintenance programs in feed mills, small as well as large. At the same time, he outlines a plan which should give maximum life together with minimum repairs for feed mill machinery. This article is from a talk by Mr. Carlson at the Central Retail Feed Assn. convention in Milwaukee.

Let us think about this comparison for a moment. You have ball bearings, sleeve bearings, gears, sliding motions, etc., in your car. These same mechanical features can be found in many of the machines in your mill. Is it not logical then to give your mill machinery the best possible care?

Can Avoid Most Failures

Maintenance is present in every mill due to normal wear of screens, hammers, grinding plates, spouts, etc. Preventive maintenance cannot eliminate this, but I can tell you that more than 50% of the mechanical failures in the feed mill today can be avoided with a good planned preventive maintenance program. You may say this sounds fantastic, but if you check the largest feed manufacturers, you will find that an accurate maintenance record is kept on most machines, and a planned preventive maintenance program is in operation. Their machine maintenance records prove the merits of preventive maintenance costs.

What is a good planned preventive maintenance program? Well, first of all top management must have a sincere interest in the program and give it continued support and co-operation. The personnel of the entire plant must be impressed with the importance of this function and told to report any unusual conditions found in the operation of the equipment.

One man with good mechanical ability should be appointed to be responsible for all preventive maintenance in the plant, and shall report directly to the mill superintendent. After this is done, you have a good foundation for organizing a program which will pay for itself many times with reduced maintenance expense.

The next step should be the procurement of the necessary tools to enable your maintenance man to do an effective job. The following is a list of the necessary tools for even the smallest manufacturer. The tools should consist of an oil can, necessary grease guns, an assortment of adjustable wrenches, socket wrenches, a pipe wrench, hammers, screw drivers, adjustable oilers, and an ammeter. The larger plants will require addi-

(Continued on page 14a)

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A New Spot Fumigant Method For Mill Insect Control

By L. E. McQuillen

Ferguson Fumigants, Inc., Ferguson, Mo.

In recent years in the milling industry, there has been a continuing trend toward increased use of spot fumigants for the control of insects in milling machinery, with an accompanying decreased use of general fumigations of the mills. General fumigation as a primary tool, involved the principle of permitting the insect population to become quite extensive, whereupon a general fumigation was performed, and if successful, the population was reduced to zero, or a near-zero point. This meant that there was only a brief period following each general fumigation, when the mill equipment was relatively free of insect population. Legal requirements and the modern concept of sanitation have necessitated the development of preventive methods which will keep the insect population to the near-zero point 365 days in the year.

Spot fumigation was first used to slow down the build-up of insect populations between general fumigations. Some mills began using larger quantities of spot fumigant at a greater degree of regularity in an effort to maintain continuing control of the insect population and eliminate general fumigation. Some mills have succeeded with this method and have effectively eliminated the necessity for general fumigations, while others have not been so successful.

Recently there has been made available to the milling industry a new spot fumigant and a new method of application. It provides for a highly concentrated spot fumigant to be applied in very tiny dosages with a special, portable applicator appropriately named the "Little Squirt" fumigant applicator. Although this material and method has only recently been made known to the milling industry, it has been the result of years of research and development.

The discovery of the special value of the fumigant composition originally occurred in connection with a general fumigation in which the mixture of methyl bromide and ethylene dibromide gave far superior results at a lower dosage than previously had been recorded with methyl bromide alone. A nationally known industrial research laboratory was commissioned to determine by laboratory tests, the reason for these superior results. This laboratory work revealed that the mixture was synergistic, or in other words, more effective as a fumigant than either of its chemical components. Application was made for a U.S. patent.

Serious work on the practical aspects of spot fumigation with ethylene dibromide-methyl bromide mixtures and applicator equipment began in 1950. Several mills cooperated by permitting their mill equipment to be used on week ends for trial fumigations. Variations of the components of the mixture were tried, and various points of application were used to determine where application should be made. It was soon determined that very tiny dosages of one to two fluid ounces were all that needed to be applied at the various points of application to get thoroughly effective results. In other words, all that was needed at each application point was just a little of the fumigant, and it became obvious that some special applicator which wou'd give a little squirt into the milling equipment and shut itself off, was needed. Improvised equipment had been used in experimental fumigations which would not be practical and entirely safe in the hands of untrained operators.

The services of a competent instrument engineer were obtained to assist in developing satisfactory applicator equipment. Several distinctly different principles were tried without success before a satisfactory method was discovered. The applicator that was developed is activated

Tom Wilkinson and L. E. McQuillen use the "Little Squirt" applicator to apply spot fumigant in an elevator leg at the Valier & Spies mill in St. Louis.

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by air pressure, usually obtainable from the mill's air pressure outlets which are available on all floors. The dosage it will deliver is adjustable from a few drops to a continuous flow. The machine is on wheels and portable, and is normally equipped with 100 ft. of plastic tubing with a small copper nozzle at the end of it, which will fit into quarter-inch ID holes bored in the equipment.

Operating the Applicator

Two men are required to operate the spot fumigant applicator. The first operator inserts the nozzle in the quarter-inch hole in the milling equipment and signals the second operator to release the fumigant. The second operator has the simple job of pressing the button on the machine, whereupon the measured amount is released through the nozzle and the flow is automatically shut off. It is a simple matter of the opertaor moving the nozzle from one hole to another. When these points of application are close together, such as in elevator heads or legs, applications are easily made at the rate of one every ten seconds. This makes it possible for two operators to do a complete spot fumigation of average size mills in one to two hours. Only the very largest of flour mills will require as much as four hours. Most average size mills require about 10 gal. of fumigant for a complete spot fumigation of all milling equipment.

The question of whether mill stock should be removed from the mill equipment before fumigation was studied. It was found that much more effective results could be obtained if no mill stock was removed, since the mill stock formed a natural seal in the equipment which slowed down leakage and maintained concentration for longer periods of time. No difficulty was encountered in completely penetrating the deepest of boot stock.

The question of safety to the operator was studied. It was found that by beginning treatment of the lower floors of the mill and proceeding upward, the operators were generally keeping ahead of the development of concentrations in the atmosphere as a result of leakage from the mill equipment. The very high specific gravity of this fumigant caused it to leak in greatest quantities at the lower portion of the equipment. Mill personnel and public health officials who have had personal experience with this fumigant and method of application, have universally considered it to compare favorably from a safety point of view with other spot fumigants commonly in use.

Several important factors contribute to safety in handling this spot fumigant with the special applicator. One, it has a strong odor normally detected as quickly as it will show on a Halide Leak Detector (between 20 and 50 ppm). Two, it is applied through a closed system applicator into a closed milling system, minimizing the development of vapors in the mill building atmosphere. Three, only two persons are involved in this application for a minimum application time. Four, the small quantity used contributes to safety. It will usually figure out that if the total quantity used for a spot fumigation in a mill were vaporized throughout the mill building, it would represent only about .01 lb. per thousand cubic feet.

Tests were run to determine the spread of the fumigant through the milling equipment from the point of application. These tests involved treating elevator heads and the upper part of elevator legs only, with test box insects spread throughout the milling equipment. In some mills, but not all mills, a complete kill of test box insects occurred on the floor of boots that had not been cleaned out. With elevator head applications only, kills were obtained in the sifters and in roll stands in some instances. These tests indicated that the fumigant spread widely through the equipment and gave effective results in remote locations.

A number of mills were found which would agree to use the Formula 73 fumigant and the "Little Squirt" spot fumigant applicator at regular intervals for an extended period of time, to determine the effectiveness of the method and material under varying conditions of practical application. This group of mills has used this fumigant continually and successfully for periods of two to four years.

The writer was milling superintendent of one of the mills which participated in these field tests. During the more than two years that the system of fumigation has been in this mill, it has ben continually essentially free of insect infestation within the milling equipment. It enabled us for the first time in our history to eliminate general fumigations of our milling units and thus reduced our fumigation cost about 50%. Our men were particularly pleased with the portable applicator which is so easy to operate and provides such rapid application of a small volume of spot fumigant.

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Q **What other advantages has PY-RAN?**

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Q **Can PY-RAN be used in conjunction with other phosphate leavening agents?**

Yes. PY-RAN will blend perfectly with other leavening phosphates such as Monsanto SAPP and HT phosphates.

Q **How can I find out more about PY-RAN?**

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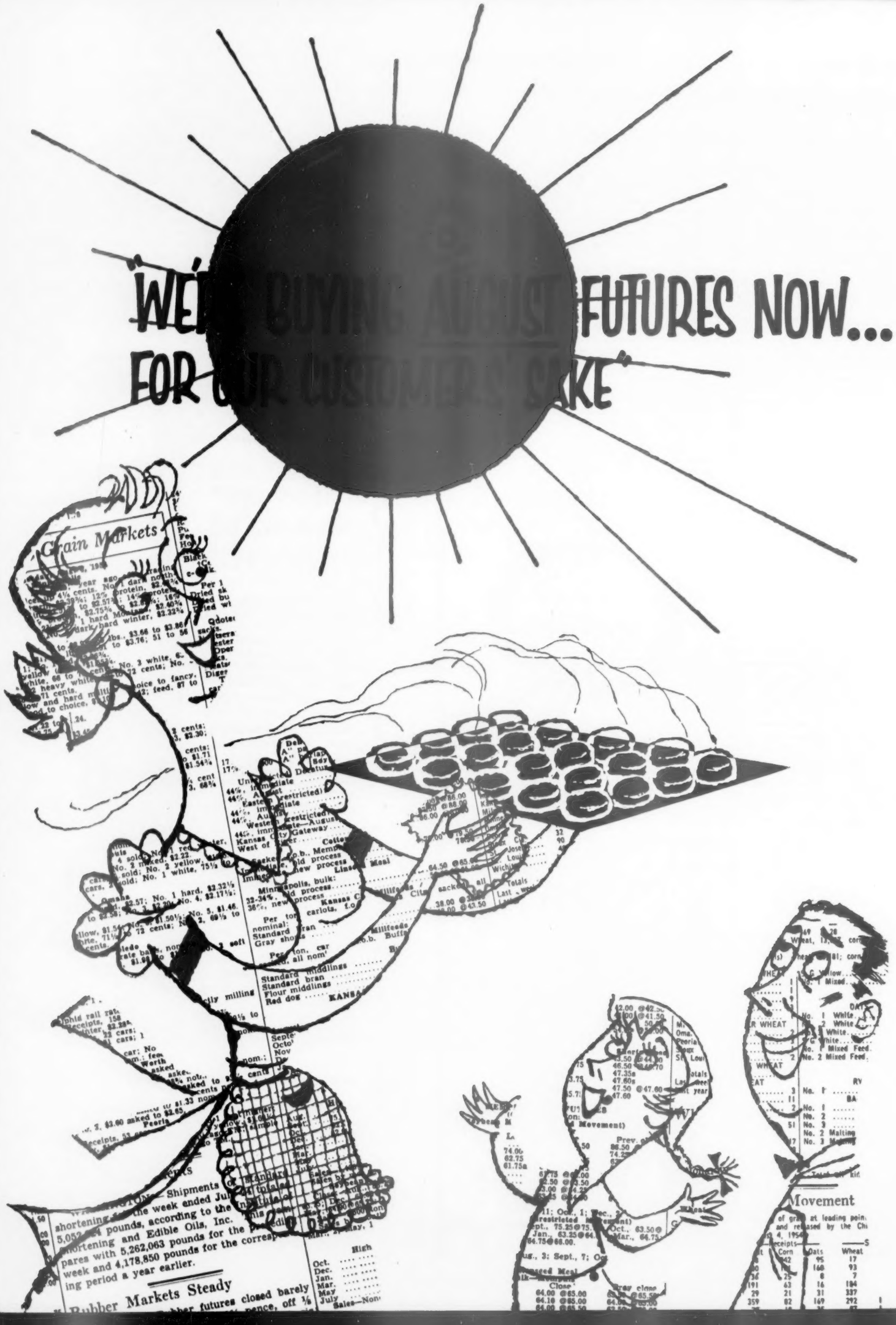
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Old Timer: "Yup! We're buying August futures now, for the sake of our customers."

Upandcomer: "Really, Old Timer, aren't you blowing your cork on this one? There *are* no August futures."

Old Timer: "That's where you're wrong, Sonny. I'm talking about a mighty important August 'future'. . . I mean our *sales* of self-rising flour and corn meal *next* August when heat and humidity are putting the squeeze on shelf life and kitchen performance. I'm talking about a sure-fire 'hedge' against complaints and poor baking performance next summer."

Upandcomer: "Say! If you can make *that* kind of a hedge, it will take a lot of the risk out of next summer's production. But how are you going to control the weather?"

Old Timer: "That's just the point! No one can control the weather but we *can* do something to protect our brands. The best protection we can give our self-rising flour and corn meal is to contract for next summer's supply of V-90. Then we *know* our brands will have maximum shelf life and a kitchen performance that will bring customers back for more."

Upandcomer: "Is V-90 *really* that good?"

Old Timer: "Well . . . figure it out for yourself. We've been using V-90 for *15 years* and we've never had to worry over shelf life. *15 summers* have come and gone and our sales of self-rising flour and corn meal have shown a steady increase. That's why we're sure . . . *dead* sure . . . that V-90 will bring us through next summer. And that's why we're contracting for V-90. It's a sure-fire deal to protect August 'futures'. . . *next* August sales, that is!"

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MAINTENANCE

(Continued from page 9a)

tional power tools to facilitate larger repair jobs which can be done by specially trained mechanics.

The next step is to obtain instruction sheets from the machinery maufacturers giving operating and lubricating instructions for each machine in your plant. Normally the necessary instruction manuals are shipped with the equipment and should be preserved for reference as necessary for operation, lubrication and repair.

The most important function of the maintenance man is to lubricate all machines and equipment in strict accordance with the manufacturers' recommendations. Bearings may require lubrication twice daily, or in some cases only once a year, depending on the loads, speeds, and normal operating temperature. Bearing failure may be caused by too much grease (which very often happens) as well as inadequate lubrication. A high speed ball bearing on a hammer mill, for example, will build up a terrific amount of heat when it has too much grease. This heat is generated by the internal churning action within the bearing, and before long can get hot enough to soften the working parts of the bearing. It is needless to say that a bearing failure will be inevitable if the grease is not removed from a hot high-speed bearing. Some operators have been known to pump additional grease into a hot bearing believing that the bearing was dry. Other reasons for hot bearings may be misalignment or overload, which will require mechanical adjustments to correct this condition.

Oil levels in gear cases must also be checked periodically to make certain adequate lubrication is present. The recommended oil should be added if necessary to bring the oil level to normal. Many manufacturers recommend flushing and changing the oil in gear cases twice a year (spring and fall) to maintain a clean and proper lubricant for summer and winter operation.

Head drives for bucket elevators fall into this specific classification. Roller chain drives, linkages and sliding motions should also receive attention in the form of proper lubrication and inspection. This by no means covers the field of lubrication in the feed plant, but we must move along to other duties of the maintenance man.

Do not expect your maintenance man to be a lubrication expert. My point here is that the machinery manufacturer can best recommend the lubrication procedure for his machines. He sincerely wants you to receive the best possible performance from his machinery, and recommends the lubrication and operation procedures with this in mind.

Inspect Machines

Another function of the maintenance man is to visually inspect each machine as he lubricates it. He should check for signs of possible trouble. The warning signals may be in the form of strange knocks or squeals in the machine, or may be misalignment, excessive wear or even a change from normal machine production. Any of these could indicate that something is wrong and should be checked and corrected immediately if possible. A minor adjustment or repair at this time could eliminate a major breakdown later on.

Electric motors should be kept clean and free from dust accumulation. Dust and other foreign materials form a blanket of insulation which prevents proper heat dissipation from the motor. A condition of this kind can cause a motor failure on a fully loaded motor which requires maximum heat dissipation. Keep your motors clean.

As long as we are talking about electric motors, let us discuss the use of the ammeter we have provided for the maintenance man. This ammeter should be the clip-on type with a capacity of at least 200 amps. A suitable inexpensive ammeter is on the market today for less than $50. As most of you know, all of the necessary electrical data for any motor can be found on the nameplate. It is good preventive maintenance to check the amperage on each motor in your plant when it is in normal operation, and compare these readings with the full amperage on the name plate. If the ammeter reading is higher than the nameplate rating, definite steps should be taken to either increase the size of the motor or decrease the load to the motor capacity.

The overload protection device for each motor should also be checked to be sure it is the proper size for the motor and is in good operating condition. It is a very good idea to have your local electrician work with your maintenance man on at least the first electrical inspection tour of your plant. After your man becomes familiar with the checking procedure, he can check the amperage of any motor or replace the heater coil in a motor starter if necessary.

Replacing Parts

Now in addition to these preventive maintenance duties, your maintenance man should be prepared to

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replace machine parts due to normal wear, make adjustments as required on the equipment, and perform minor repairs. The smaller mills may have a man devoting only part time to maintenance work, whereas a large feed mill can have up to four full time maintenance men on the job. Obviously the smaller operator must obtain outside help to complete major repairs when a breakdown occurs. Most large mills have adequate facilities to handle most any major repair job.

Up to this point, we have management pushing this preventive maintenance program, plant personnel have been alerted, and a good mechanically minded individual has been appointed responsible to management for the program. The manufacturers' instruction sheets for the operation and lubrication of the equipment have been received. We also have a small shop equipped with the necessary tools to carry out the program. In addition to all of this preparation, we have instructed our new maintenance man on his responsibilities and duties in detail.

There is, however, one very important part of this program that we have not considered as yet. That is, how are management and the maintenance man to know which bearing is to be lubricated next, especially when there is such a wide time interval range recommended for different bearings. When were they lubricated the last time? These are questions which must have positive answers to get the most benefit from the preventive maintenance part of this program.

Lubrication Charts

Some firms are using lubrication charts for each machine in the plant. These individual machine charts are usually 8½x11 in., and are placed in a notebook for ready reference by the maintenance man or management. The name or number of the machine is placed on top of the chart with a column on the left side listing each point of lubrication on the machine. The next column may list the type of lubrication to be used, and following this is the column showing the recommended lubrication time lapse interval for each bearing. Following these columns the sheet should be squared off to provide spaces for the maintenance man to enter the dates he lubricates each bearing. The bottom of each sheet should have space for general remarks concerning each machine in the plant.

You may say this chart is unnecessary, and what's more, we do not have time to prepare it. I must admit it will take some time to prepare it, but I will not admit that it is unnecessary. You can use ordinary ledger paper for the charts if you like, or a master chart can be prepared and run on a duplicating machine. However, the blank charts must be made out for each machine to suit your individual desires. You will be amazed at the information that can be available to you concerning your machinery from a well prepared chart system.

I have tried to impress upon you the importance of a good preventive maintenance program. I have also presented an outline of what I consider to be a good workable plan which should give you maximum life.

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Need for Conveyor Belt Safety Stressed

Ever since man began manufacturing things, he has needed conveyor systems of one type or another. The earliest ones date back several centuries to indicate that our ancestors were ingenious enough to utilize the law of gravity and crude logs for conveying materials and streams of water were also used extensively as conveyors.

The Chinese have used bucket conveyors for hundreds of years and still make use of them for lifting water from streams. Power for these projects is furnished by coolies walking on treadmills; a primitive arrangement, but one which has worked for a long time.

With the advance of civilization and the attendant need for more manufactured products in keeping with higher standards of living, efficient devices for conveying materials in manufacturing, have become a necessity.

EDITOR'S NOTE: This article is from a talk by R. G. Diserens before the fertilizer section at the Southern Safety Conference in Louisville. The author is safety director for Phillips Chemical Co., Bartlesville, Okla. Although the remarks were addressed to fertilizer manufacturers, they also will be of interest to persons in other fields where conveyors are used.

Unfortunately, the frequency of accidents in connection with handling materials has increased greatly; to

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the extent that this is regarded as being hazardous work.

It seems rather strange, that industry has learned to manufacture with safety, products that are highly toxic, very explosive, extremely inflammable and possessing other dangerous properties; and yet the accident rate on material handling devices is still high. After coping successfully with other hazards of explosiveness, toxicity and flammability, why should there be further danger in handling these products after they are manufactured?

Since most conveying systems are of rather simple construction and travel relatively slowly, there is a tendency toward overlooking much of the preventive maintenance accorded operating equipment. We must remember that the conveying equipment is a definite part of operations and deserves some attention both from a safety and maintenance standpoint.

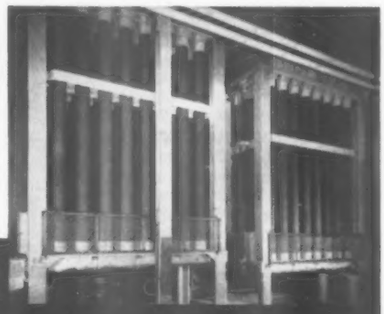
Improperly maintained and makeshift types of conveyors contribute to the frequency of accidents. The makers of such contrivances apparently have but one thought in mind: that of merely conveying material, to the exclusion of all considerations of safety.

We have several different types of conveyors, including belt, screw, bucket, chain, blower, trolleys and monorails, not to mention several others. We will mention only certain types, starting with belt conveyors.

First we should know the type of accidents that occurs when using this type of conveyor. Some of the most common occur when: the employee gets his hand caught between the belt and the pulley; or caught in the drive "V" belts or drive chain; making adjustments on equipment while it is in motion; riding on conveyors, oiling, climbing over, unplugging jams and starting equipment when other employees are working on the equipment.

These are but a few of the common causes of accidents on belt conveyors. In order to reduce the frequency of these accidents, a few basic practices and regulations need be applied. When new conveying equipment is to be installed, safety engineers should work with the design section, thus eliminating some of the obvious hazards. Proper guards for gears, belts, etc., must be included; location of masterswitches studied; walkways along side of conveyors should be installed if needed; and electrical interlock and emergency shutdown switches should be part of the equipment.

Let us elaborate on these items a



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bit. I believe everyone is familiar with proper guarding of gears, belts, pinchpoints, etc. These guards should be made of heavy materials. So often we find that guards, made of light materials, become so bent and distorted that when once removed they will not fit again. Masterswitches should be located so as to be accessible for "locking out" procedures.

On long permanent conveying systems, walkways with guard rails and toeboards should be installed so that equipment can be repaired, oiled, checked, etc. thus minimizing personnel exposure. Two or more independently driven sections of conveying equipment should be interlocked so that when one section is shut down, all sections preceding will be automatically shut down also, thus eliminating pile-up of materials.

Suppose a maintenance man is working on a section of equipment and the operator is told or assumes, without checking, that the maintenance man has finished. The operator then pushes the button starting the equipment and the maintenance man is caught in the machinery. In order to prevent this, the starting switch can be located so that the operator will be forced to go to each section and therefore he can see that everyone is in the clear before starting the equipment.

When repairs are to be made, there should be some method of being sure the equipment can not be started until the repairs have been completed. The two methods most widely used on electrically driven equipment are the lockout and tagging procedures. When using the lockout method the masterswitch is pulled and locked out with the foreman in charge of repair, or the maintenance man doing the work in possession of the key.

When using the tagging system, signed tags are used in place of padlocks. When more than one group of craftsmen are working, such as welders, mechanics and electricians, multiple locks or tags are used. Each craft must respect the other craft's lock or tag in order to make these methods successful. (When doing extensive repairs, some plants disconnect the electric wires from the motor.)

Whistles and horns are sometimes used to signal the starting of equipment. However, due to their loud noise, men often make these devices inoperative by attempting to mute them.

Accumulation of materials on the drums or tail pulley should not be removed while equipment is running. To prevent employees from attempting this, some plants extend heavy mesh guards several feet from pulleys. Crossovers or walkways should be installed to prevent employees from climbing over conveyors.

Several of the hazards found when operating belt conveyors are also present when operating screw conveyors. Quite often the screw conveyor is driven with a chain or sprocket. These chains and sprockets should certainly be properly guarded.

One of the most hazardous situations arises, however, when some employee removes a section of the conveyor covering to work on a hanger and fails to replace the cover. The results are that some employee may step into the conveyor and be seriously injured.

Bucket conveyors are usually enclosed; however, keeping the inspection doors in place presents a considerable problem. Keeping the inspection doors in place can be done best by making frequent inspections. The gears and drive should be guarded the same as on other types of conveyors.

GRAIN SEPARATION

(Continued from page 1a)

tions for maximum efficiency, various combinations of speeds and projection angles were investigated using a uniform sample of wheat. Typical results are illustrated in Figure 2 which shows the effect of varying speeds with common projection angle of 30 degrees. These curves indicate clearly the effect of speed of projection in determining the distance traversed by the kernels and the character of the distribution of grain fractions among the various receiving bins. Analysis showed that the most effective separation with a projection angle of 30 degrees was obtained at a speed of 1470 ft. per minute (940 rpm). This is approximately the terminal velocity of moderately heavy wheat.

In general, greater separation was achieved by increasing the belt speed as indicated by the increased spread of the curves. The advantage of greater spread was reduced, however, by the tendency of the grain to "fly" in an uncontrolled manner at speeds higher than 940 rpm. Best operating results were obtained when the grain is projected angularly upward, due to the increased time the grain interacts with the frictional forces of the air

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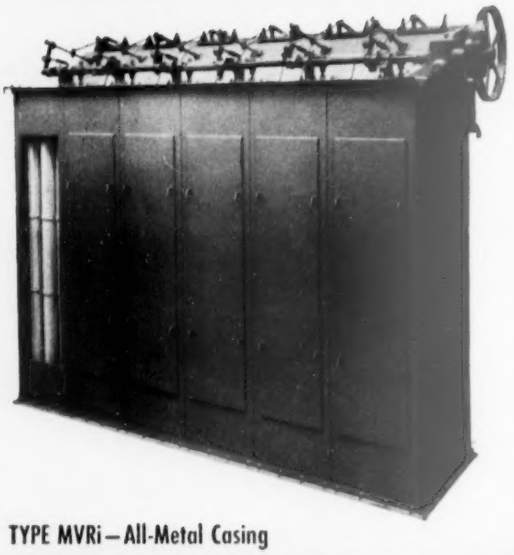

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Table 2—Distribution and Test Weight for Separations of Wheat, Screenings, Sorghum and Corn

Bin No.	Wheat %	Wheat Test wt.	Screenings %	Screenings Test wt.	Sorghum %	Sorghum Test wt.	Corn %	Corn Test wt.
15	.4	57.1	0.8	48.3	1.2	28.5		
16	.2	57.1	0.4	48.3	0.8	28.5		
17	.2	57.1	0.3	48.3	0.7	35.9		
18	.2	57.1	0.4	48.3	0.8	35.9		
19	.3	57.1	0.6	48.3	1.0	39.2		
20	.3	57.1	0.6	47.7	1.1	39.2		
21	.4	56.1	0.9	47.7	1.3	44.3		
22	.5	56.1	1.5	47.7	1.8	44.3		
23	.7	56.1	1.5	47.7	1.9	47.3		
24	1.0	56.3	2.8	50.2	2.4	48.5		
25	1.4	56.3	3.8	51.3	2.7	49.5	0.7	54.9
26	2.1	56.5	5.3	53.0	3.3	50.9	0.3	54.9
27	3.1	56.7	6.9	53.8	3.8	52.2	0.4	54.9
28	4.3	57.0	8.4	54.7	4.2	53.0	0.4	54.9
29	6.9	57.4	11.7	55.6	5.4	54.1	0.6	54.9
30	8.6	57.7	11.9	56.4	5.6	55.3	0.6	54.3
31	12.2	58.1	13.3	57.3	7.4	56.4	0.9	54.3
32	13.7	58.5	11.0	58.0	9.1	57.4	1.4	54.3
33	14.9	58.8	8.8	58.7	11.7	58.3	1.5	54.3
34	13.5	59.1	6.4	59.2	13.2	58.8	2.2	54.3
35	9.4	59.5	2.5	59.6	11.7	59.3	2.9	54.9
36	4.2	59.8	0.7	...	6.2	59.7	4.0	56.0
37	1.2	59.9	0.2	...	1.9	60.0	5.1	56.2
38	.2	59.9	0.05	...	0.4	...	6.3	56.2
39	.1	59.9	0.03	...	0.1	...	9.6	56.4
40	.1	59.9	0.02	...	0.1	...	10.8	56.8
41							14.9	57.9
42							14.6	58.3
43							12.3	59.2
44							7.1	60.1
45							2.2	60.4
46							.5	...
47							.3	...
48							.2	...
49							.1	...
50							.2	...

as well as with gravitational forces. In the present geometry a projection angle of 30 degrees was found most effective. Horizontal projection might be equally effective if the projection system were elevated considerably above the receiving bins.

Characteristics of separated wheat fractions. The test weight, protein and ash content of fractions of a sample of wheat testing 53.5 pounds per bushel and separated by projection, are shown in Figure 3. Test weight of fractions ranged from 46.0 lb. per bushel in bin 22 closest to the point of projection, to 58.0 lb. per

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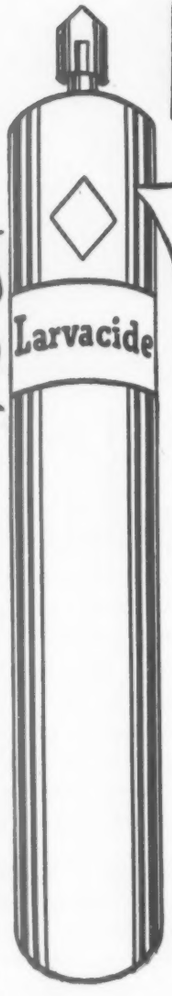

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bushel in bin 33 farthest from this point. The protein content which was 17.0% in the original sample decreased regularly in the separated fractions from 18.9 to 14.5%. The ash content which was 2.08% in the original wheat varied from 2.26 to 1.97 in the fractions. Analysis of numerous samples of wheat consisting of both pure varieties and commercial lots indicate that this grain shows a range in variability of the kind indicated in Figure 3. Results for test weight obtained on fractionating a heavier and more homogeneous wheat sample are shown in the data of Table 2.

Fractionation of infested wheat. A sample of non-infested wheat was mixed with infested kernels of the same type, to provide a mixture containing 8.5% of internal infestation as determined by x-ray. Table 1 shows the results of the separation of this sample into 16 fractions, each of which was x-rayed and counted for internally infested kernels. Considerable concentration of infested kernels occurred in bins closest to the point of projection (21-27) whereas the grain falling into more distant bins (32-36) was relatively free of infestation. X-rays of various fractions from this infested sample are shown in Figure 4. Pooling the grain which collected in hoppers 32-36 would yield almost half (48.9%) of the original sample with an infestation of approximately 1.5%, which represents a purification of six-fold. The grain falling originally into bins 27-31, comprising 49.4% of the original sample and containing excessive infestation, could be reprocessed to obtain additional segregation of infested kernels, thus permitting the reclamation of an added amount of wheat suitable for milling purposes. Practical millers or grain men would select a portion of the grain too highly infested to mill, but containing too much good grain to be consigned to screenings, for recycling or reprocessing in a second smaller machine.

Achievement of such a separation of wheat suitable for milling from a sample so heavily infested suggests the value of reprocessing wheat by this method, in order to reclaim grain for food purposes instead of condemning an entire lot of infested wheat to feed channels. Obviously the original sample could not be used for flour production since it would produce excessive amounts of insect fragments.

Reclaiming of screenings. A sample of heavy screenings was obtained from a lot of commercial wheat which had received preliminary cleaning in a milling separator, by passage through an aspirator in which the air velocity was set at a higher than normal level. These wheat screenings, testing 52.7 lb. per bushel were separated on the spectrometer into 26 fractions with test weights ranging from 48.3 to 59.6 lb. per bushel (Table 2). The data show that the spectrometer was able to reclaim a considerable fraction of the screenings as good milling wheat.

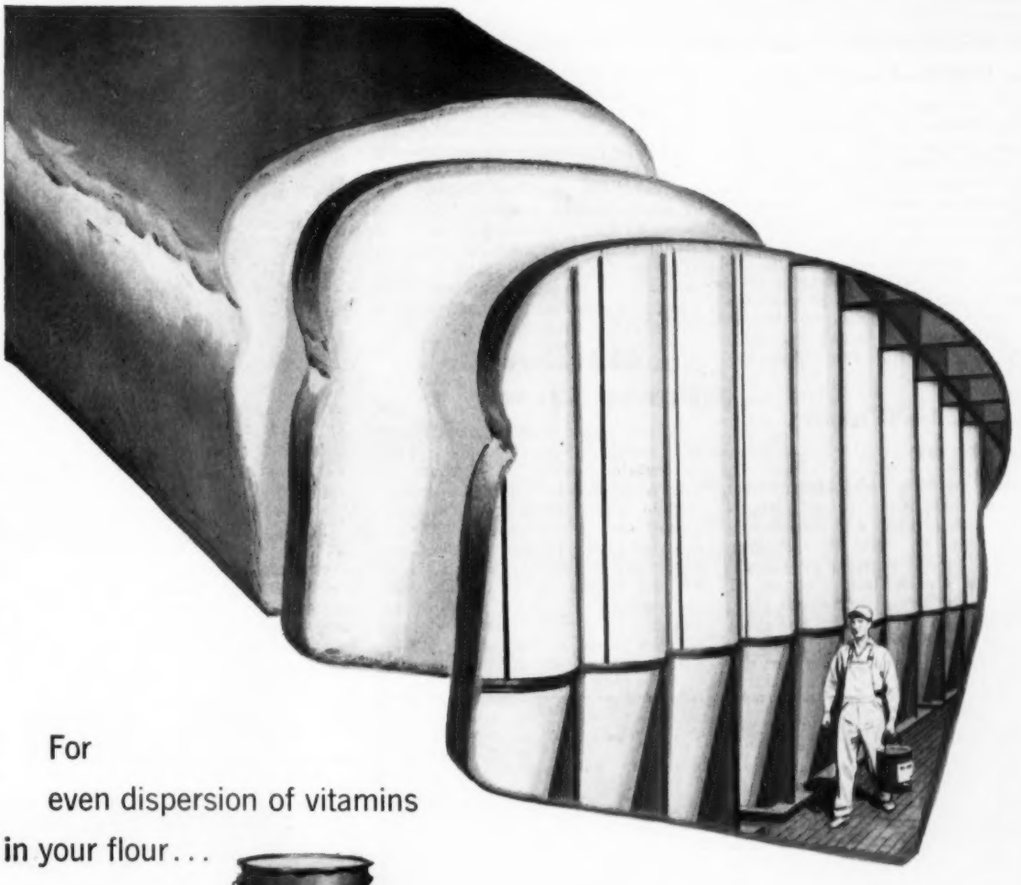
In order to keep screenings losses low and to raise yield, some mill operators set their cleaning machines to remove an insufficient amount of impurities from the wheat thus courting the risk of producing flour of poor quality. Others set weed seed separators to remove some good wheat along with the weed seeds, and then reprocess this small stream to reclaim the wheat. The present results with the spectrometer suggest that the entire cleaning system in the mill could be operated on the latter principle, the spectrometer being used for reclaiming milling wheat from the heavy screenings.

Separation of sorghum. A lot of commercial sorghum, obtained from a local elevator, was cleaned and separated by projection. The wide range in character of the fractions obtained is shown in Figure 5 and Table 2. The compartments in Figure 5 from left to right starting with the top row and proceeding to the middle and bottom rows, contain samples of fractions falling into odd numbered bins from 15 to 37 respectively.

Separation of corn. Commercial yellow corn was separated by projection. The data shown in Table 2 indicate that as with other grains, the corn was separated into fractions whose test weight increased regularly with distance from the point of projection. Corn kernels, although similar in density to wheat grains, are larger and are projected further than wheat. The first measurable amount of corn fell into bin 25, 5 ft. beyond bin 15 in which the lightest wheat, sorghum or wheat screenings collected, thus illustrating the results to be anticipated in the separation of mixed grains.

Separation of stones from wheat. Gravel of the same size as wheat was obtained by sifting river sand and collecting the material passing through a No. 6 wire sieve but retained on a No. 8 wire sieve. A sample of this gravel was anlyzed by projection and found to vary regularly in test weight from 102.4 to 114.0 lb. per bushel. The screened gravel was added to a lot of wheat to the extent of 3% by weight and mixed thoroughly with the grain. The results obtained upon fractionation of the mixture are shown in Figure 6. The gravel was strongly segregated at the extreme end of the receiver together with a small amount of heavy

(Continued on page 21a)



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New literature has been prepared by the Fischer & Porter Co. on its line of process control instrumentation for the feed and milling industries. Catalogs on stock instruments, all-metal flow measuring instruments, continuous viscosity controllers and flow ration control systems are available. The company has complete details available on its viscosity controller in the application of molasses to cattle feed. To secure this literature without charge check No. 2992 on the coupon and drop it in the mail.

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A new, portable telescoping wheel conveyor that opens to any length between minimum and maximum spread with no drop in conveyor level, has been developed by Associated Metal Fabricators, Division of Jersey Sheet Metal Products, Inc. Listed as Model No. 75 Tel-O-Veyor, the new conveyor can be used in multiple units or attached on existing conveyor line. It is used within plants to increase the efficiency of product flow, particularly to simplify aisle cross-overs. Loading and unloading operations are also speeded with Tel-O-Veyor, and it may be carried inside a truck without loss of payload space. The unit telescopes down to 4 ft. 4 in. and may be effectively used at any length up to 10 ft. 2 in. Operating surface is 12 in. wide. It weighs approximately 70 lb. For more complete information check No. 6127 on the coupon and mail it.

No. 6134—Mobile Power Shovel

A new small, mobile power shovel with a capacity of 11 cu. ft. or 1,200 lb. suitable for handling grain, fertilizer, chemicals and other loosely packed bulk materials in close quarters is now in production by the Industrial Truck Division of the Clark Equipment Co. Named the Bulk Master, the shovel has an outside turning radius of 73 in. It is suited for working in narrow aisles and tight corners, such as found in boxcars. Other dimensions: length, 109 in.; width, 46½ in.; overall height, 60 in.; weight, 4,400 lb. Full-shovel lifting speed of six seconds, dumping speed of one second and lowering speed of three seconds, with a dumping angle of 60 degrees, are features of the machine. Check No. 6134 on the coupon and mail it to secure more complete information.

No. 2994—Feed Mixer

The announcement of a new addition to its feed mixer line has been made by the Strong-Scott Mfg. Co. Called the "Uni-Blend," this mixer is claimed to meet the need of the commercial feed plant for a moderately priced mixer to apply liquids such as molasses, animal fats, or fish solubles to either light or relatively heavy ingredients. It embodies the tandem mixing principle and utilizes slow rotor speeds. Thus fragile ingredients, such as rolled grain, will maintain their identity, but can still be blended in high capacities, it is claimed. The mixer's slow speed subjects the ingredients to a gentle mixing action rather than a beating. The product contains all the necessary equipment for adding liquid ingredients to dry feeds in one complete system, the company states. The unit design eliminates accessory equipment and simplifies installation. It is necessary only to connect power, heat, and ingredient supplies and the machine is ready to operate. For more complete details check No. 2994 on the coupon and drop it in the mail.

No. 2983—Cable Coating

New developments in the use of nylon sheathed thermocouple cables for temperature indicators in grain bins have been announced by E. I. du Pont de Nemours & Co., Inc. Cables sheathed in extruded Zytel, trade name for the company's nylon resin, are claimed to be successful in withstanding the abrasive and breaking power of grains, especially corn and soybeans. The cable is made of strong steel wires and thermocouple wires embedded in Zytel. The entire cable is then cased in this nylon for further protection. Tested in a 90 ft. bin, the cable met a 7,500 lb. load test. The nylon was unscarred during tests approximating four years of hard use, according to the company. To secure more complete details about the use of this product check No. 2983 on the coupon and drop it in the mail.

No. 2995—Engineers' Brochure

A 29-sheet technical brochure on concrete stave storage bins (silos) is available upon request to recognized engineers by the Neff & Fry Co. The brochure contains table of cubic foot weights of flowable materials, bin capacities per foot of height, description of wall construction, information on concrete staves with test data, detail drawings of stave, rods, and lugs, specifications and drawings of concrete roof, photos of foundation curb on common roof of adjacent bins for supporting superstructures, photos of access opening and trap door in roof, details of 45° elevated floor and overflow partition, details of exterior safety ladder, details of wall openings including gates, frames, and chutes, details of boiler-house coal bins and photos of typical installations. Check No. 2995 on the coupon and mail it to obtain the brochure.

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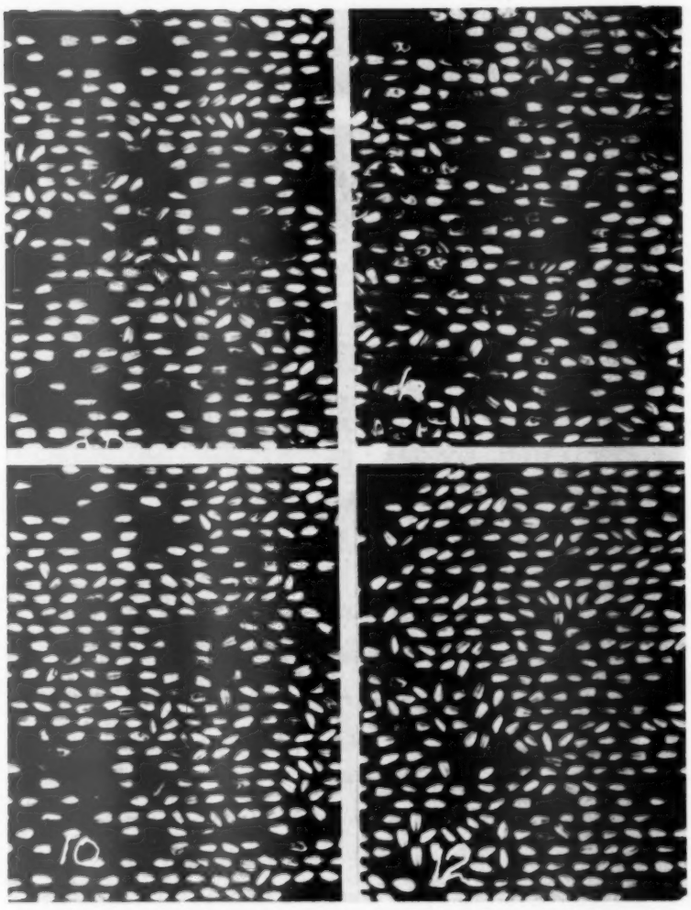

FIG. 4—X-rays of infested grain. Left to right and top to bottom, these represent: The original sample (8.5% infested), the fraction received in bin 26 (30.9% infested), fraction received in bin 30 (7.9% infested), and fraction received in bin 32 (1.5% infested). The progressive decerase in the number of infested kernels with increasing bin number is also accompanied by a decrease in stage of maturity of insects within the infested kernels.

GRAIN SEPARATION

(Continued from page 19a)

wheat. Thus the sample in the final bin, constituting 0.92% of the original mixture tested 78.4 lb. per bushel and contained 54.6% gravel by weight. These results demonstrate that the separation of stones from grain, which hitherto has required wet stoners, can be done efficiently with the grain spectrometer without wetting the grain.

Conclusions

The grain spectrometer can perform many functions of standard grain cleaning equipment now in use in mills and grain warehouses, but in addition it provides new cleaning and separating functions not previously possible. The tests reported here indicate that this instrument is capable of segregating internally infested kernels from sound grain, classifying wheat into a series of fractions of progressively varying test weight, and of separating out high protein fractions from commercial wheat. The appartus performs an efficient recovery of sound wheat from screenings, removes stones from commerical wheat which can not be accomplished by conventional dry grain cleaning methods, and separates mixtures of grain of different species. Moreover, The apparatus performs an efficient continuous on-the-stream basis which suggests that operating costs would be nominal under farm and commercial conditions.

Practical conditions would probably require not more than 3 to 5 bins, with movable baffles to adapt the apparatus to a variety of materials to be processed, and to the changing requirements of the separation. Obviously, greater capacity could be achieved by increasing the belt and hopper widths.

References

(Data presented in the sections on "Characteristics of separated wheat fractions" and "Fractionation of infested wheat" were adapted from previous publications (1,2).)

1. Katz, R., Milner, M., and Farrell, E. P.—The separation of grain by projection. Cereal Chem. 31:316-325 (1954).
2. Milner, M., Farrell, E. P., and Katz, R.—The separation of grain by projection. II. Systematic differences in physical properties and composition of wheat fractions. Cereal Chem. 516:326-322 (1954).

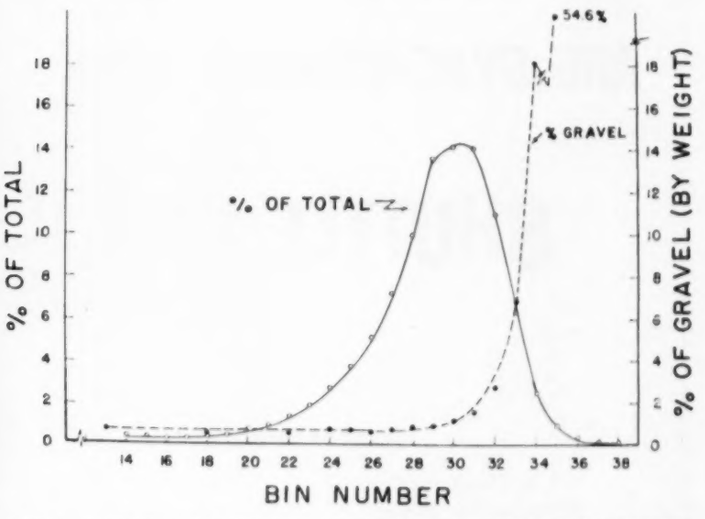

FIG. 6—Separation of gravel from wheat. The two curves show the distribution of total material and the percentage of gravel in the various bins.

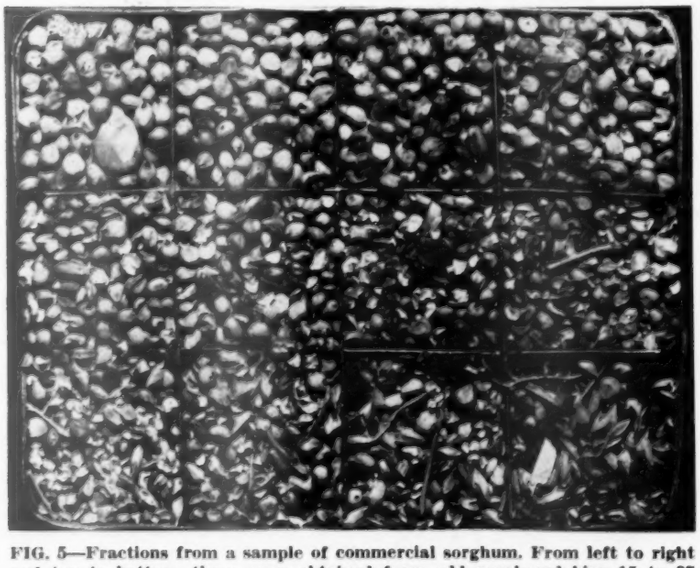

FIG. 5—Fractions from a sample of commercial sorghum. From left to right and top to bottom, these were obtained from odd numbered bins 15 to 37 inclusive.

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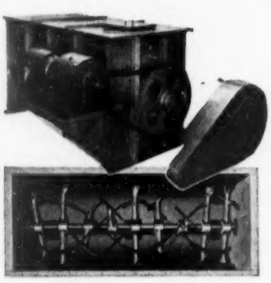

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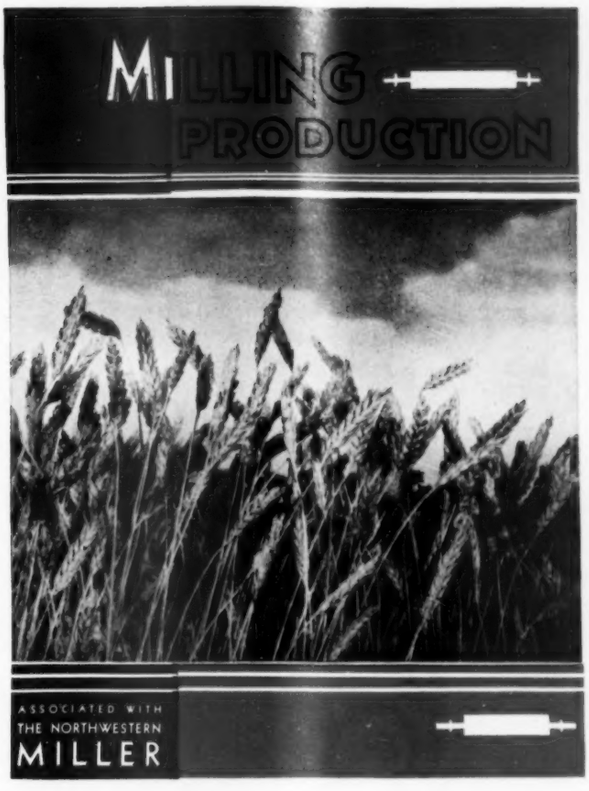

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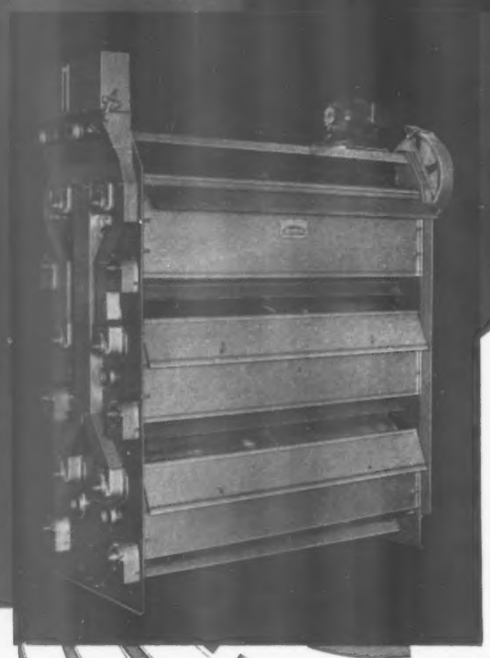

NO. 532 CARTER PRECISION GRADER

FIG. 2

FIG. 3

To separate or size various materials, Carter Precision Graders use *perforations*—much as perforations have been used for centuries in flat screen machines. But Precision Graders incorporate two *exclusive* features that enable the perforations to separate or size accurately and uniformly:

1. A sure method of bringing the material into contact with the perforations

When used for separating or sizing by *thickness* differences, the Precision Grader uses cylinders (Fig. 3) that have slotted perforations at the bottom of grooves (Fig. 2). Saddles between these grooves tend to upedge the material, presenting it to the slots. The thinner material passes through the slots, the thicker material passes over and is conveyed to the end of the cylinder by the spirally placed grooves.

For *width* sizing or separating, round recessed perforations are used (Fig. 4). The recess causes the material to be presented to the round perforations in an upended position. Thus the narrower passes through, and the wider goes over to discharge at end of cylinder (Fig. 5).

2. A method of keeping the perforations open

The perforations are kept open by means of multiple rubber strips on a rotating shaft. These strips gently tap the outside of the cylinder near its top (where there is no mass of material resting against the perforations) and prevent the perforations from clogging.

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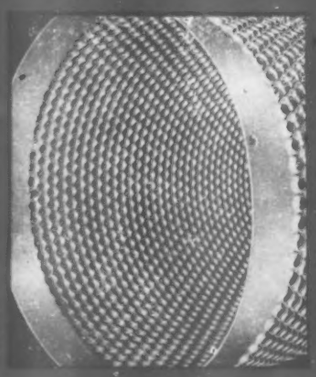

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